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AMERICAN VERSUS BRITISH MACHINERY.

We have no desire to enter into a fruitless discussion of the relative merits of the various makes and designs of sugar house machinery which has occupied so much space in recent numbers of our exchanges. So far as the Hawaiian sugar planters and manufacturers are concerned, the question admits of no discussion. The modern designs of sugar house machinery which long ago supplanted the British styles in the mills of these Islands, are entirely of Amèrican construction and design.

The Hawaiian planters, we believe, get as good results from their mills as are obtained in any other sugar growing country. The extensive plants existing on nearly all of our plantations are the result of the increase of sugar production in these Islands during the past twenty years, and the high standard of centralization, which demands the very best of machinery with the greatest capacity.

On very many of the plantations, in fact on all of the larger plantations, nine roller mills of American construction are in use. The grinding season lasts from three to eight months, depending upon the output of the individual plantation, and when a supply of labor warrants, the mills are run night and day.

There is at the Oahu Plantation a twelve-roller mill, which we believe to be the only ōne in existence. This mill was designed and constructed by the Honolulu Iron Works and, upon the showing made by the mill for the season of 1903, the Hawaiian Sugar Company of the Island of Kauai have given an order to the same company for the construction of a similar mill at their plantation at Makaweli. This latter mill will supplant the only remaining diffusion plant in operation on the Hawaiian plantations.

The Manager of Oahu Plantation, in speaking of his twelve-roller mill, says the same has proven a success, and that with very slight dilution, a remarkably high extraction has been attained.

Exact figures, however, owing to inclement weather since grinding at that mill, are not given.

Olaa Sugar Company has a nine-roller mill, constructed by the Honolulu Iron Works, which is a typical modern mill in use upon many Hawaiian plantations. The output of this plantation is about twenty thousand short tons of sugar. Extracts from the mill report for the season of 1902-1903 may not be out of place:

MILL REPORT—SEASON OF 1902-03, OLAA SUGAR CO.

Extraction—91.92 total sugar; 79.58 cane; 12.898 per 100 cane.
Bagasse—4.91 total sugar; 22.847 cane; 1.132 sugar per 100; 45.87 moisture.
Press Cake—7.63 total sugar; .0796 cane; 0.568 sugar per 100.

	Brix.	Polarization.	Purity.	Glucose.
1st mill juice	18.04	16.42	91.04	0.597
Mixed	15.94	14.26	89.43	0.525
Clarified	16.23	14.73	90.74	0.554
Syrup	57.27	51.63	90.32	1.590
Press juice	9.42	8.41	88.21	....
1st molasses	80.47	52.33	65.32	....
2nd molasses	84.06	32.72	38.92	....
Waste molasses	84.95	28.30	33.17	....
Dilution	12.05	....	....	....
Fibre in cane	10.93	....	....	....

PRODUCED.

36,904,555 lbs. No. 1 Sugar 99% of 86.63° Polarization
269,500 lbs. No. 2 Sugar 00.72% of 94.83° Polarization
209,490 lbs. Estimate in Mill of 96.00°.

LOSSES.

	Per 100 Cane.	Lbs. Sucrose.	Per 100 Sucrose in Cane.
In Bagasse	1.132	3,410,616	8.08
In Press Cake	0.079	239,987	0.508
In Molasses	0.554	1,521,625	3.650
Undetermined	0.375	1,129,976	2.612
	2.140	6,302,204	14.910

Hours Grinding	3,143 1-3
Days Grinding (of 23 hours)	136.65
Tons of Cane Ground	150,644.504
Tons of Cane Ground per Day	1,102.4
Tons of Cane Ground per Hour	47.93

Tons of Sugar Produced			18,587.0875	
Average Polarization Shipped	96.61°	on	18,537.1825	Tons
Average Polarization Sold	97.15°	on	18,390.7725	"
Actual Loss in Weight	.764%	on	141.41	"
Actual Gain by Polarization	.5588%	on	103.557	"
Actual Loss Over All	.2052%	on	37.853	"
Tons of Sugar Produced per Day				136.01
Sugar per 100 Cane				12.33
Tons Cane per Ton Sugar				8.10
Pounds Sugar per Ton Cane				246.76
Average Tons Pressure on 1st Mill				388.0
Average Tons Pressure on 2nd Mill				407.5
Average Tons Pressure on 3rd Mill				419.5
Barrels Lime used in Manufacture				716.5
Pounds of Lime per Ton Sugar				7.7

The mill report of the Waialua Agricultural Company is also interesting:

MILL REPORT—CROP OF 1903, WAIALUA AG. CO.

Extraction by Mill—95.65 % of total sucrose in cane.

Hours grinding, actual time	4,135
Days grinding, including the total number of days steam in mill	182
Tons of cane ground	153,442
Tons of cane ground per day	843
Tons of sugar manufactured crop of 1903	19,768
Tons of sugar manufactured including product of molasses sugars, crop of 1901 and 1902	19,800
Tons of sugar manufactured per day, including total number of days steam in mill	109
Tons of cane per ton of sugar	7.76

This plantation produces about twenty thousand short tons of sugar per annum.

We venture to say that there are few plantations which can show a better record than the factory at Puunene, Maui.

We are indebted to Mr. J. N. S. Williams, M. I. Mech. E., who is Chief Engineer and Mill Superintendent of the Hawaiian Commercial & Sugar Company, for his pamphlet on "Recent Practice in the Design, Construction and Operation of Raw Cane Sugar Factories in the Hawaiian Islands," which contains excerpted minutes of proceedings of the meeting of the "Institute of Mechanical Engineers," in London, December 19, 1902. Mr. Williams' article is a description of the manufacture of sugar at the mill of the Hawaiian Commercial & Sugar Company, which plantation has an annual output of over thirty thousand tons of sugar. This mill was erected by the Honolulu Iron Works, and is designed to grind a maximum of 3,600 tons of cane per day of twenty-four hours.

The machinery and apparatus consists of three sets of crushing plant mills, each of capacity to grind 1200 tons of cane per twenty-four hours; twenty boilers with individual furnaces and fuel feeders; two sets of conveyors and carriers for elevating and distributing the cane refuse to the furnaces; clarification and filtration plants; two Lillie quadruple effect evaporators; six vacuum pans, each capable of making 100 tons of dry sugar per day; 30 crystallizing tanks; 20 centrifugal machines and incidental and appurtenant apparatus.

Mr. Williams' article deals with the season of 1902. Owing to a scarcity of labor, and a comparative short crop—22,000 tons of sugar—it was decided to operate only one milling plant. The mill report for the crop of 1902 as published by Mr. Williams is as follows:

"CROP REPORT.

"Crop 1902. Puunene Mills, H. C. & S Co.
"Maui, Hawaiian Islands.

"Crop commenced 10 a. m., January 29, 1902.
Crop finished, 9:55 p. m., November 29, 1902.
Total cane ground, 194,754 tons
Total commercial sugar made from this cane, 25,117 tons.
Cane per ton sugar, 7.75 tons.
Total time of grinding, 4,312½ hours.
Cane ground per hour, 45.16 tons.
Juice (dilute) per 2,000 lbs. cane, 1,830 lbs.
Dilute juice, 17.64 per cent. brix. equals total soluble solids.
Dilute juice, 15.26 per cent. polarization.
Dilute juice, 86.5 quotient of purity.
Dilution, 15.08 gallons per 100 gallons of original juice.
Fibre in cane, 11.33 per cent.
Waste molasses, 89.46 per cent. brix.
Waste molasses, 35.28 per cent. polarization.
Waste molasses, 39.42 quotient of purity.
Average polarization, "A" sugar, 96.97 per cent.
Average polarization, "B" sugar, 95.06 per cent.
General average, "A" and "B" sugar, 96.75 per cent.
Losses in manufacture:

In crushing and extraction.....	8.37 per cent
Between mills and vacuum pans.	1.58 per cent
In waste molasses	6.90 per cent
Not specially accounted for.....	1.27 per cent
	18.12 per cent
Pure sugar in cane ground.....	100.00 per cent

Note.—The reason that the net results of manufacture for the whole crop are not as good as those for the first three months of grinding, as previously detailed, is because during the latter part of the crop the cane was deteriorating very rapidly, and quick milling could not be resorted to, as the bulk of the labourers on the plantation were engaged in planting for the crop of 1904, which contingency was brought about by the crop exceeding the estimates at the commencement of the grinding by over 3,000 tons of sugar."

The discussion following upon the reading of Mr. Williams' paper are highly interesting and show that the British manufacturers do not adequately appreciate what is required in a mill of a highly centralized plantation.

CALCULATIONS USED IN CANE SUGAR FACTORIES.

"Calculations Used in Cane Sugar Factories" by Irving H. Morse is the title of a hand book recently published in neat and convenient form by John Wiley & Sons.

The author states in the preface that "this collection of tables, formulae and methods of calculation has been made for the benefit of the sugar chemist of Louisiana and other countries manufacturing cane-sugar."

The book includes a large number of tables and formulae including that for available sugar published some years ago by Prof. J. T. Crawley in the Louisiana Planter and while many of these are not applicable in Hawaiian sugar houses, and a number in use here are omitted, any Hawaiian sugar chemist will find it a valuable addition to his working library.

Attention is drawn to the three distinct applications of the term "extraction" prevailing in Louisiana, Hawaii and Cuba.

These the author designates as "mill," "sucrose" and "sugar extraction" respectively.

Although the book is claimed to be but a compilation of tables and formulae there are scattered through the preface and the body of the work a number of observations so much to the point that they will bear repetition.

A few of these are:

"A good chemist should be thoroughly familiar with the practical side of the manufacture in order to more readily see the information most needed."

"The main object of carrying on the (sugar) business is the recovery of the greatest amount of sugar at the least cost, and the chemist should always keep this before him during the season if he desires to become valuable to his employer."

"The object of good sugar-boiling and sugar-drying is to obtain the greatest amount of sugar in one operation."

"It is important that all the products should be analyzed by the same method for the entire season."

RECENT EXPERIMENTS WITH SALINE IRRIGATION.

C. F. ECKART.

In the annual report of the Experiment Station for 1902, considerable space was devoted to results obtained from irrigating sugar cane with water containing 200 grains of salt per gallon. The investigations discussed at that time comprised small lysimeter experiments and dealt with the solvent action exerted on the soil elements by saline water, and the toxic effect of various salts on the growth of cane.

It was found that when occasional excessive irrigations were applied to cane growing in tubs, (constructed so as to allow of free drainage), the use of irrigation water of high salt content only checked in small measure the growth of the cane. It was also shown that large quantities of lime were liberated from the lysimeter soils through displacement by the sodium in the irrigation water, and it was indicated that the lime chloride so formed had a smaller toxic effect on the cane than a like amount of sodium chloride in the soil water. The data contained in this report are the results of investigations pursued in the field, where the information gained from the lysimeter tests was applied on a larger scale for confirmation of results.

Nine plats, each 1500 sq. feet in area, were laid off in the Experiment Station field, planted with Lahaina cane, and treated as follows:

Plat No. 1—Fresh water was applied in irrigation. Fertilization was at the rate of 100 lbs. of Nitrogen (1-3 organic, 1-3 from nitrate of soda, 1-3 from sulphate of ammonia); 200 lbs. of potash as sulphate of potash; and 50 lbs. of phosphoric acid as double superphosphate per acre.

Plat No. 2—Irrigation was the same in quantity as in Plat No. 1 but contained 200 grains of salt per gallon. Two tons of lime in the form of ground coral were added to the plat after the cane was a foot high and partially incorporated with a superficial layer of the soil. Mixed fertilizer applied as in Plat No. 1.

Plat No. 3—Irrigation and mixed fertilizer applied as in Plat No. 2. Instead of ground coral, 2 tons of lime in the form of gypsum were mixed with the soil.

Plat No. 4—Irrigation and mixed fertilizer, the same as in Plat No. 2. No lime added.

Plat No. 5—Same irrigation as in Plat No. 2. Mixed fertilizer at the rate of 100 lbs. nitrogen as nitrate of soda; 200 lbs. potash as sulphate of potash; and 50 lbs. phosphoric acid as double superphosphate per acre.

Plat No. 6—Same irrigation as in Plat No. 2. Mixed fertilizer at the rate of 100 lbs. nitrogen as sulphate of ammonia; 200 lbs.

potash as sulphate of potash; and 50 lbs. phosphoric acid as double superphosphate per acre.

Plat No. 7—Same irrigation as in Plat No. 2. Mixed fertilizer at the rate of 100 lbs. nitrogen as dried blood; 200 lbs. potash as sulphate of potash; and 50 lbs. phosphoric acid as double superphosphate per acre.

Plat No. 8—Irrigated with fresh water, a heavy irrigation being applied every eighth watering. Mixed fertilizer applied at the rate of 100 lbs. nitrogen as sulphate of ammonia; 200 lbs. potash as sulphate of potash; and 50 lbs. phosphoric acid as double superphosphate per acre.

Plat No. 9—Irrigated with same quantities of water as Plat No. 8, water containing 200 grains salt per gallon. Fertilization the same as in Plat No. 8.

IRRIGATION OF SALT WATER EXPERIMENTS.
(INCHES.)

Month.	Rainfall.	Irrigation Plats 1-7.	Irrigation Plats 8 & 9
June, 1902	.96	2.0	2.0
July	2.21	5.0	5.0
August	1.46	4.0	8.0
September	2.19	4.0	4.0
October	2.25	5.0	9.0
November	8.35	2.0	2.0
December	8.12	1.0	1.0
January, 1903	3.28	2.0	6.0
February	4.32	1.0	1.0
March	.68	5.0	5.0
April	2.11	3.0	7.0
May	2.05	4.5	4.5
June	.83	7.5	11.0
July	1.67	8.0	8.0
August	2.20	8.0	11.0
September	4.98	8.0	8.0
October	1.75	6.0	8.0
November	2.24	5.0	5.0
December	1.30	..	..
January, 1904	4.88	..	..
February	24.10	..	..
March	6.04	..	..
April	2.11	..	..
	90.08	81.0	105.5

Plats Nos. 1 to 7 inclusive received the same volume of irrigation water, 2 inches being the maximum amount applied at one time. Plats Nos. 8 and 9 received ordinarily the same irrigation as the other plats, but for every eighth watering this was increased to 5 inches. The dates on which Plats 8 and 9 received a 5-inch irrigation were: August 6th, and October 2nd, 1902, and January 20th, April 21st, June 17th, August 5, and October 21st, 1903.

The volume of rainfall and irrigation received, together with amounts of salt applied per acre are next given:

Plat.	Rainfall Gallons.	Irrigation Gallons.	Salt per Gal. Grains.	Salt Applied per Acre. Lbs.
1	2,446,032	2,199,474	....	....
2-7	2,446,032	2,199,474	200	62,842
8	2,446,032	2,864,747	....	....
9	2,446,032	2,864,747	200	81,850

Plats Nos. 1 to 4 constitute the lime tests. It is to be regretted that limited field space would not permit the carrying out of experiments in which fresh water and gypsum, and fresh water and ground coral were applied for comparison of results, so obtained, with results from Plats Nos. 2 and 3 receiving ground coral and gypsum respectively but irrigated with salt water. We would then know more exactly the percentage of gain in sugar yields which could be attributed to the ordinary agricultural value of the lime applications, and also the gain due to the neutralization of the salt carried into the land with the irrigation water. It is quite safe to assume, however, that owing to the nature of the station soil it would not show any appreciable gain from treatment with gypsum and ground coral where fresh water is used in irrigation. The lime in this soil is unusually high, showing by absolute analysis 1.01 per cent, by the agricultural method, .861 per cent, and by the aspartic acid method, .325 per cent. The gypsum through its indirect action would liberate considerable quantities of potash, which would allow the presence of so much more available potash in Plat No. 3; the heavy potash fertilization of these plats, 200 lbs. per acre, however, together with the amount made available by the salt would minimize the effect of potash liberated by the gypsum. This latter point is clearly brought out by the yields of sugar from plats Nos. 2 and 3 which are almost identical.

The quality of the juice and the quantity of cane and sugar produced per acre in the first four experiments are shown in the following tables:

QUALITY OF JUICE.

Plat	*Salt per Gal. of Water Irrigation*	*Form of Lime Added*	*Brix of Juice*	*Sucrose of Juice*	*Glucose of Juice*	*Purity of Juice*	*Gums of Juice*	*Chlorine. per Gal of Juice*	*Salt per Gal. of Juice*
1	None	No lime	20.28	18.90	.312	93.20	.43	9.8	16.17
2	200 grains	G. coral	16.46	14.40	.264	87.50	.53	93.1	153.63
3	200 grains	Gypsum	16.56	14.50	.271	87.60	.56	84.94	140.17
4	200 grains	No lime	15.89	13.80	.280	86.8	.50	105.24	173.67

CANE AND SUGAR PER ACRE.

Plat	*Salt per Gal. of Water*	*Form of Lime Added*	*Cane per Acre, Lbs*	*Sucrose in Cane Per Cent*	*Sugar Per Acre, Lbs*	*Percentage Gain Through Use of Lime.*
1	None	No lime	151,675	16.91	25,648	....
2	200 grains	Ground Coral	42,311	12.88	5,449	46.6
3	200 grains	Gypsum	42,108	12.97	5,461	46.9
4	200 grains	No lime	30,085	12.35	3,715	....

The most striking point in regard to these results is the great difference in sugar yields displayed between the plat receiving fresh water and the plats receiving irrigation containing 200 grains of salt per gallon. The difference in the amounts of sugar produced, approximated 11 tons, and this was caused by the application of no salt in the one instance and practically 31 tons per acre in the other.

The juice of the cane receiving saline irrigation was characterized by lower density, less sucrose and glucose, a lower purity, and a much larger content of salt, than the juice of the cane receiving fresh water. Where lime in the form of ground coral and gypsum was applied a better showing was made in regard to density, sucrose, glucose, purity, and salt content, than where no lime was added. The percentage of gain in the former instance was a trifle higher than in the latter.

The gain in the sugar of the cane where ground coral was applied was 46.6 per cent, and with gypsum 46.9 per cent, compared with the plat that was not limed. The difference in the amounts of available sugar would be somewhat higher than these figures owing to the difference in the purity and salt content of the juices.

The influence of the form of nitrogen, applied in mixed fertilizers, on the yield of sugar in salt water plats may be seen from the following figures:

QUALITY OF JUICE.

Plat	*Form of Nitrogen in Mixed Fertilizer*	*Salt in Irrigation Grs per Gallon*	*Brix of Juice*	*Suc of Juice*	*Gluc of Juice*	*Purity of Juice*	*Gums of Juice*	*Chlorine of Juice Grs. Per Gallon*	*Salt of Juice Grs Per Gallon*
4	3 forms of Nit.	200 grs.	15.89	13.80	.280	86.8	.50	105.24	173.67
5	Nit. of Soda	200 "	16.86	14.70	.286	87.2	.53	66.04	108.98
6	Sul. of Am.	200 "	16.80	14.90	.297	88.7	.62	67.67	111.62
7	Blood	200 "	16.96	15.2	.328	89.6	.63	86.10	142.08

CANE AND SUGAR PER ACRE.

Plat	*Form of Nitrogen in Mixed Fertilizer*	*Salt in Irrigation Grs Per Gal*	*Cane Per Acre Lbs*	*Sucrose in Cane Per Cent*	*Sugar Per Acre Lbs*
4	3 forms of Nitrogen	200 grs.	30,085	12.35	3,715
5	Nitrate of Soda	200 "	35,515	13.15	4,670
6	Sulphate of Ammonia	200 "	31,218	13.13	4,161
7	Blood	200 "	57,963	13.6	7,882

The largest production of sugar was obtained where the entire amount of nitrogen was applied in the form of dried blood. While a small gain was to be expected, owing to the salt water having but little effect on nitrification, (see report for 1902, page 61) from the use of dried blood for Lahaina cane under Experiment Station conditions, we were surprised at the large difference in yields. The yields of sugar from Lahaina cane harvested at the same time, and which received the same fertilization, but to which fresh water was applied in irrigation were as follows:

Form of Nitrogen in Mixed Fertilization.	Sugar per Acre. Lbs.
Dried Blood	22,254
Nitrate of Soda	21,262
Sulphate of Ammonia	19,262

The order of yields in the salt water plats was the same as the above, although the percentage of gain from dried blood was greater. The more vigorous cane produced by fertilization with dried blood, withstood the deleterious action of the salt in a more pronounced manner than the cane in the other plats.

EFFECT OF OCCASIONAL HEAVY IRRIGATION ON YIELDS OF SALT WATER PLATS.

It was shown in the report for 1902, that when cane was grown in tubs, allowing a perfect drainage, an occasional heavy irrigation, by leaching accumulations of salt from the soil, permitted an almost normal growth. In the field this perfect drainage cannot be obtained, but a heavy irrigation, now and then, is capable of reducing the salt content of the soil to such an extent that the cane is checked in less measure than where the salt is allowed to accumulate in larger quantities.

This is fully shown by the following figures:

QUALITY OF JUICE.

Plat	*Irrigation*	*Salt in Irrigation Per Gallon*	*Brix of Juice*	*Sucrose in Juice*	*Gluc of Juice*	*Purity of Juice*	*Gums of Juice*	*Chlorine of Juice Grs Per Gallon*	*Salt of Juice Grs Per Gal*
6	Normal	200 grs.	16.80	14.90	.297	88.7	.62	67.67	111.62
8	Excess	None	20.02	18.7	.288	93.4	.54	8.63	14.24
9	Excess	200 grs.	16.08	14.0	.272	87.1	.30	109.44	180.6

CANE AND SUGAR PER ACRE.

Plat	*Irrigation*	*Salt in Irrigation Per Gallon*	*Cane Per Acre Lbs*	*Sucrose in Cane Per Cent*	*Sugar Per Acre Lbs*	*Per Cent Gain over No. 6*
6	Normal	200 grs.	31.218	13.33	4,161	....
8	Excess	None	182,981	16.73	30,612	....
9	Excess	200 grs.	62,494	12.53	7,830	88.1

The cane on these plats was grown under the same conditions except with regard to irrigation. Plat No. 6 received a normal volume of water weekly, while Nos. 8 and 9 received an occasional heavy watering (5 inches every 8th irrigation). Plats Nos. 6 and 9 received water containing 200 grains of salt per gallon, and No. 8 received fresh water.

The extra irrigation water applied to Plats Nos. 8 and 9 amounted to 24.5 inches. This quantity when fresh increased the amount of sugar by 4,964 lbs. or 19.3 per cent; where salt water was used the gain was 3,669 lbs. of sugar or 88.1 per cent. If a gain in Plat No. 9 were entirely due to an increased growth resulting from a larger available supply of water in the soil, we would expect the percentage of gain in yield to be somewhat proportional to that in Plat No. 8; this would allow the production of 4,964 lbs. of sugar. The difference between the yield of Plat No. 9, 7,830 lbs., and 4,964 lbs. would represent approximately the gain from the leaching effect of the extra irrigation applied. The difference amounts to 2,864 lbs. of sugar or 68.8 per cent. The investigations of 1902 and those recently completed in the field justify the following conclusions.

CONCLUSIONS.

Lime is a potent agent in modifying the deleterious effect of saline irrigation on the growth of cane. On the Experiment Station field, application of lime in the forms of ground coral and gypsum and at the rate of 2 tons of lime per acre resulted in a gain of sugar amounting to 46 per cent; the irrigation water containing 200 grains of salt per gallon.

Occasional heavy irrigations given to a moderately porous soil receiving brackish irrigation, is most effective in reducing the salt content of the soil to a less toxic quantity. A gain of 88.1 per cent. of sugar was obtained in the Experiment Station field by a 5-inch irrigation every 8th watering; at least 77 per cent of this gain may be attributed to the leaching of salt accumulations from the soil.

Aug. 8th, 1904.

LECTURES ON THE DISEASES OF THE SUGAR-CANE.

By L. Lewton-Brain, B. A., F.L.S.

(Continued from Page 283.)

ROOT DISEASE OF THE SUGAR-CANE.

In my previous lectures, I spoke first of the sugar-cane in health, and then of it as attacked by two of the more important stem diseases, the rind disease and the pine-apple disease. With both of these diseases we found we could deal; the rind disease has, for the present at least, been kept under by the use of resistant varieties of cane, the White Transparent and various seedling canes; the pine-apple disease of cuttings has been proved, on an experimental scale, to yield to treatment with Bordeaux mixture.

IMPORTANCE OF ROOT DISEASE.

There still remains to be considered the root disease, a disease which has probably caused more damage during the past few years than all other sugar-cane diseases together. It appears to attack equally well all varieties of cane at present in cultivation and yields to no fungicidal treatment. It is a most interesting disease from the point of view of the plant pathologist, in that I know of no other in which host and parasite are so evenly matched, so that a small disturbance in the external conditions may very easily lead to one or other getting the upper hand, and possibly it is this that makes some planters appear unwilling to assist the sugar-cane in what appears to be a fair fight. But it is precisely this weakness, if I may put it so, in the parasitic qualities of the *Marasmius*, that makes it such an insidious and dangerous enemy, and, moreover, so difficult a one to deal with.

SYMPTOMS OF ROOT DISEASE.

The fungus attacks ratoons more frequently than it does plant canes, but it is often to be found on plant canes, although it may be doing comparatively little damage.

The symptoms of the disease are well marked, and if careful examination be made of the canes suffering from it, there is no chance of its being mistaken for any other.

LEAVES.

The leaves first show signs of the disease; instead of a dozen or so broad, bright-green leaves we get fewer leaves and these drying up much earlier than they should do. The drying up takes place first at the tip and edges of the leaf and gradually spreads until the whole leaf is dry and withered. The younger leaves, before even they begin to turn yellow, do not open out as they should do; they remain partially rolled up, in the manner I spoke of in my first lecture. Evidently the plant is suffering from lack of water, the leaves farthest from the main axis, and first the parts of them which are farthest removed, are drying up and dying, while the younger leaves, which are still receiving a certain amount of water, roll up to reduce the water lost by the process of transpiration. These then are the first noticed symptoms of root disease; but it may be said they might equally well be due to drought. This is quite true, but it will be noticed that other plants in the same field and exposed to exactly the same conditions, do not show them or show them to a less extent.

LEAF-BASES.

If now we examine the bases of such plants we find still more marked characteristics of the disease. The old dry leaf-sheaths, which in a healthy plant are thrown off, leaving the base of the stem clean, remain attached and require considerable power to remove them. On examination, we find that they are all matted together by a clean-looking, white felt which is the mycelium of the fungus *Marasmius*. The matted leaf-bases have a characteristic musty smell.

ROOTS.

Pulling off this mass of dead leaf-bases, we notice at once that the roots, which normally spring from the nodes, burst through the leaf-bases and then grow down into the soil, are not developing properly. Either these roots do not develop at all or their growth ceases when they are about one-quarter to one-half-inch long. The tips of the aborted roots are reddish or blackish in color. The undeveloped roots are indicated by brownish spots in the rind of the cane.

EFFECTS ON GROWTH.

The canes attacked by the root fungus are usually considerably dwarfed in comparison with others in the same field; not only are fewer leaves developed but the stems are much thinner and drier and usually shorter than normal canes.

Again, the diseased canes are very easily uprooted; the slightest pull is sufficient to remove the stool; whereas, as you know, considerable force is required to uproot a healthy stool of canes.

Finally, from the base of the stool, or from the roots, arise the fruits of the fungus which causes the root disease. These are small, white or yellowish toad-stools and one usually finds them in groups. They are rarely to be found except in wet weather and the best time to look for them is in the early morning before the sun has dried them up.

With all these points characteristic of the disease, there ought to be no difficulty in recognizing it wherever it occurs.

STRUCTURE OF TOAD-STOOLS OF MARASMIUS.

The toad-stools are the spore-bearing parts of the fungus and so their structure demands our special attention. Each one consists of two parts—a slender stalk or *stipes*, and a cap or *pileus*. On the under sides of the cap there hang down a number of gills or *lamellae*; these lamellae are regularly arranged radiating out from the centre of the cap, near the insertion of the stalk, to the margin; they are occasionally branched. Both cap and stalk are, of course, composed of hyphae which are all alike or nearly so, but the hyphae differ from those of the other fungi we have examined, in being far more regularly arranged. In the stalk, although they branch and interweave, so giving firmness to the mass, the general course of the hyphae is vertical and they run approximately parallel to one another. Similarly in the cap the hyphae generally run regularly, radiating out from the point where the stalk is attached to the margin, while some of them turn down and form the gills. The structure of the gill also demands our attention as it is upon it that the spores are formed. To see its structure we cut a section tangential to the cap, in which way, of course, we get a cross section of the gills.

STRUCTURE OF GILLS.

In the centre of the gill we get hyphae running more or less parallel down from the cap. Those near the edge turn out at right angles to the general direction and the ends of these hyphae become the spore-bearing organs of the fungus, which are here known as *basidia*. These basidia have a special structure which is constant through and characteristic of the highest group of the fungi, the Basidiomycetes, to which the mushrooms, toad-stools and puff-balls belong. A basidium is a club-shaped hypha, at its free end it puts out a definite number of tiny branches, the *sterigmata*, at the end of each of which a single spore is formed. The number of pores formed on each basidium is thus a definite one. In *Marasmius*, as in most cases, it is four; sometimes it is two or eight, but for any Basidiomycetous fungus it is a definite number. These basidia form a definite layer on the outside of the gills, which they cover like a palisade tissue.

We thus see that the structure of the spore-bearing part of *Marasmius* is a highly specialized one. We find the gill has a definite structure, a central part, the *stroma*, then a definite *subhymeneal layer*, where the hyphae are turning out, and then a definite *hymenium* composed of the basidia; the basidia again are definite in size and form and bear a definite number of spores.

NUMBER OF SPORES PRODUCED.

Now I wish you to notice the immense number of spores that are produced. Every gill is covered by closely packed basidia, each one of which produces four spores. We can get some idea of the number by taking off the cap from its stalk, and laying it flat upon a piece of black paper and covering it with a bell-jar or anything that will keep off the wind. The spores, which are white, fall on the paper as they ripen and give a print of the gills, which can be fixed by gum arabic. When you reflect that the mass of white powder is composed of spores, which are so small as only to be distinguishable with a microscpe, you will get some idea of the myriads of spores found on each toad-stool.

SPREAD OF FUNGUS BY SPORES.

Now one of the ways in which the root fungus spreads from plant to plant is by means of these spores. Under natural conditions the spores are shed at the base of the cane plant and are thence carried away either by wind or insects. As each spore is capable, if conditions be favourable, of infecting a cane plant with root disease, it does not require much imagination to realize that those canes near a group of the toad-stools have a very good chance of becoming infected, if only by this means, while there is quite a fair chance of the light spores being blown by the wind to canes at a greater distance.

GERMINATION OF SPORES.

The spores form a good starting point from which to begin the study of the life of the fungus. They will germinate in a drop of water on a cover slip and then each puts out a short hypha and no more. If we remove this hypha on the end of a sterilized needle to a sterilized slab of cane in a tube, it will go on growing. Compared with those of the rind fungus, the hyphae are small and very closely woven; moreover, their growth is much slower. Another point about these hylhpae, which is characteristic of all Basidiomycetes, is their possession of clamp connexions, which put the segments of a hypha into closer connexion one with another.

INFECTION OF SUGAR CANE BY SPORES.

Now imagine what happens when one of these spores is carried by the wind and gets on a cane plant. In all probability it will fall on one of the leaf-sheaths and will lodge somewhere between the sheath and the stem. Here it has a nice sheltered situation, plenty of moisture and a supply of food. The chances are that the spore will germinate and soon give rise to a mycelium, which at first grows in, and obtains its nourishment from, the dead and dying tissues of the leaf-sheaths.

It passes from one of these to another and, by its dense matted habit of growth, binds them all together in a close, decaying, musty smelling mass, in the manner that is doubtless familiar to everybody here. In a similar way, the fungus spreads to any dead or dying part of the plant above or below ground. The older roots and other old dead parts of the cane plant in the soil are all infected and permeated by the mycelium of *Marasmius.*

The fungus now holds a position, as it were, surrounding the attacked plant, and simply watches its opportunity for doing it damage. When this comes, it is the young growing root that is attacked and this is entered at its most vulnerable and most important part and that is the growing point.

ATTACK OF FUNGUS ON ROOTS.

You remember that the growing region of the root is composed of a number of very delicate, thin-walled cells, full of protoplasm and actively dividing. Constant supplies of sugar and other food materials are continually being sent down from the leaves to be used up in the formation of new tissues, which takes place here and only here in the root. You see, then, that the growing point forms a very nice source of food for the fungus, plenty of food-supply and only very thin, delicate cell walls to break through in order to get it. The growing point is covered by a cap of dead cells—the root cap, which serves to protect it from mechanical injury by the particles of soil, but the root cap is no protection against the attacks of a root fungus like *Marasmius.* The hyphae penetrate in and among the dead and dying cells of the cap and draw nourishment from them, just as they do from the dead tissues outside the plant—the trash, etc.

EFFECT ON PLANT OF FUNGUS ATTACK.

The fungus does no other damage and attacks no other part of the plant; it simply enters the tissues of the growing point and destroys them. This is the cause of the dark color of the root-tips which I mentioned as one of the symptoms of root disease. But you will see that this is quite enough to affect seriously the growth and nourishment of the cane. It is at the growing point alone that the formation of fresh tissues takes place; consequently, when this is destroyed, the growth of that root is stopped. I explained in my first lecture how the older roots of the sugar-cane are continually dying away and that these are replaced by new roots which are continually being developed. Now if these new roots are constantly destroyed as soon as they start their growth, the plant must endeavor to replace them again by other roots, and so continually draws on its food material. Meanwhile, the plant is continually getting less and less able to supply the food required. As roots die away and are not replaced by others, the water and mineral salts from the soil are absorbed in gradually decreasing quantities, consequently the leaves are unable to manufacture so much of the sugar and proteid substances, which are required for use during growth.

EFFECT ON ABSORPTION AND GIVING OFF OF WATER.

The first sign of the disease is due to the cutting off of a part of the water supply. At this time the leaves have not begun to suffer and so are transpiring freely, while the roots are not taking in the full amount of water. The effect on the plant is the same as that of excessive drought. The leaves under these conditions roll up in order to lessen the loss of water by transpiration, and with plants infected with root disease this condition becomes more or less permanent. In this way, a balance is struck between the absorption and the loss of water. But you will see at once that the state of these plants is not a healthy one.

EFFECT ON FOOD SUPPLY.

In the first place, if the water current be reduced, so must be the supply of nitrates and other mineral salts from the soil which travel in it. In the second place, the same mechanism that will protect the stomata from giving out their full amount of water vapor into the air must, of necessity, prevent them from taking in the full amount of gases from the air—they are, in fact, shut off from free communication with the outer air. The most important of these gases is carbon dioxide, from which the plant obtains its carbon which it requires for the manufacture of sugar and all organic foods.

So you see, one of the first indirect actions of the root disease is to affect the activity of the leaves and to prevent the free formation of sugar and other organic matter.

In this way, the food supplies of the plant are attacked at both ends, at the roots, and the leaves, and this at a time, it must be remembered, when the plant requires more food than usual in order to replace the roots which are being killed off by the fungus.

STARVATION OF SUGAR-CANE PLANT.

The fungus has now established itself on its host. The latter gradually becomes weaker and weaker, owing to the process of slow starvation I have described. You will understand, now, how the external signs of the root disease are brought about. The stunted habit of the plant is due to inability to form new organs properly owing to lack of nourishment, while the ease with which the plant is uprooted is due to the non-development of roots, which are the anchoring as well as the absorbing organs of the plant.

REPRODUCTION OF FUNGUS BY TOAD-STOOLS.

Later on in the year, usually during the wet season, the fungus proceeds to reproduce itself. This is done by putting out the small toad-stools, the structure of which I have already described, on which the spores are borne. These toad-stools usually grow out near the ground, either from old dead roots or from the trash, etc., at the base of the stem.

RESISTANCE OF SUGAR-CANE.

The cane does not, of course, always succumb to the attack of the fungus in the manner I have described, and you can easily understand how this may be. The fungus will establish itself, as before, on the old leaf-sheaths and other dead parts and be ready to attack the roots. But suppose a plant cane is growing vigorously and under favorable conditions, it will be able to form new roots so abundantly and so fast that the attack of the fungus produces little effect on them. The same thing, of course, may happen after the fungus has commenced to do damage, if the conditions change and become such as favor root development.

But in both cases the fungus is there; it is not killed off but exists as a saprophyte on the outside of the plant: it is simply 'biding its time.' Now, suppose a dry spell sets in; root development is checked; fewer roots are formed and these grow more slowly and less vigorously. The fungus will be able to set in and destroy those that are formed, and that at a time, you will see, when the plant is in urgent need of a complete root system to extract all the available water from the soil.

ATTACK OF FUNGUS ON RATOONS.

A plant cane may and often, I might even say usually, does recover, in part at least, from the root disease, unless the season is exceptionally unfavorable. But if this cane is allowed to ratoon, the conditions are at once changed entirely to favor the fungus. It has a good hold in the dead tissues of the old cane stump: the weather is usually very dry, and the soil, not being cultivated, is tightly packed. Under these conditions, the growth of the buds at the base of the cane stump is very slow and the conditions both as regards moisture and aeration are entirely unfavorable to the vigorous and rapid growth of roots. Consequently the fungus is able to attack and destroy the majority of the roots put out, and when the rains come, the plant is not in a position to take advantage of the abundant water supply. The ratoon, in fact, never gets a fair start, and in consequence its growth throughout is weak and slow.

SPREAD OF FUNGUS BY MYCELIUM.

Hitherto we have considered the fungus as attacking a single plant, and there still remain the methods by which it spreads from one host plant to another, and the manner in which it remains in a field and tides over from one crop to another.

The spores, of course, are one means by which the fungus spreads from one plant to another. But these are not produced all the year round and they do not account, entirely, for the gradual way in which the disease spreads, from an infected plant as a centré ,in ever widening circles.

The fungus travels underground by its mycelium. As I have already mentioned, the mycelium is able to live on dead organic matter and there is always plenty of decaying cane trash and similar matter in the soil. The mycelium then grows along, starting from an infected plant, to one piece of trash after another until it comes near another cane. It proceeds to infect this in the same manner as if it had been developed from a spore.

INFECTED FIELDS.

In the same way a field remains infected with the diseaes. Any old cane stump or piece of trash is a sufficient source of nourishment for the mycelium and on these the toad-stools may be produced. If then any infected stump is brought near a growing cane, the mycelium passes from one to another and so the story goes on.

REMEDIES.

Now let us see what remedial treatment we can bring to bear on this disease.

FUNGICIDES.

In the first place treatment of the soil with fungicides has been proved to do no good, as all of those tried have been shown to have no effect on the fungus. Even if they had, the treatment could hardly be carried out on an estate scale.

IMPROVED CULTIVATION.

We must, in every possible way, increase the vigor of the canes. I have already pointed out that a cane growing vigorosuly is not likely to be damaged, seriously, by the root fungus. The soil should, therefore, be cultivated as thoroughly as possible, so as to give the roots the best chance of developing and at the same time to weaken the fungus.

CULTIVATING RATOONS.

The question of cultivating ratoons has been brought forward, but in Barbadoes it has been found that the reduction of the capilliarity of the soil caused by forking, and possibly also the disturbing of the stumps in the process, do more harm than the resulting areation of the soil does good. So that in the drier districts of the island the tilling of ratoons is generally found to do harm, though in the wetter districts it sometimes does good.

ISOLATION OF DISEASED CANES.

When only a small patch in a field is attacked and the disease is noticed in time, this area should be isolated from the rest of the field to prevent the fungus spreading by its mycelium underground. This can be done by digging a trench around the area, to such a depth that it goes below the level of the roots of the canes, that is about a foot or so. In this isolated area should also be included one or two rows, all around, of apparently healthy canes.

USE OF HEALTHY CUTTINGS.

Again the utmost care should be taken in selecting cuttings for cane plants. These should come from the very healthiest and strongest canes available. If this be done, not only will direct infection of the young plant be avoided, but there is just the possibility that in this way you may obtain canes which are more resistant to root disease. The same care should be used in selecting plants for supplying. I have seen plants used for this that were badly infested with root disease, in this way forming a centre from which the fungus could spread to the surrounding healthy plants.

RATOONING.

Then we have the question of ratoons. My own opinion is that whenever a plant or a field it attacked by root disease, it should not be allowed to ratoon. Many people, however, will prefer to take their chance, unless the canes, as plants, have suffered badly; there is of course the chance that, with vigorous plants and favorable conditions, the ratoons may pull through, but I think that, with the present system of cultivation, the odds are against them, and a badly attacked ratoon crop giving the fungus a fresh hold on the soil.

DESTRUCTION OF INFECTED MATERIAL.

Then we have the disposal of infected material. In the case of human diseases all such matter is destroyed by burning or deep burial. The same should be done with matter from diseased plants; none of it should be allowed to come in contact with healthy canes. All cane stumps infested with the *Marasmius* mycelium should if possible, be burnt, otherwise they may be buried, mixed with lime, but not in a cane field. Trash from infested fields should not be used in cane fields, nor should it be made into pen manure which is to be applied to canes. It may be used on land which is to be planted in cotton or in any other crop which is not liable to root disease.

ROTATION OF CROPS.

Again land which has borne a badly attacked crop of canes should be rested for two or three years. With a one crop system, such as still obtains to a great extent here, it is difficult to rest the land for a sufficient time to starve out the fungus. Cotton, however, offers itself as a remunerative crop and I look upon it as one of the chief advantages of the introduction of this cultivation, that it offers planters a chance to rest badly infested fields for a year or even two years.

POSSIBILITY OF RESISTANT VARIETIES.

Finally we have the possibility of raising varieties of cane which are resistant to root disease. This is the means by which we were freed from the rind disease. So far as I have seen, however, we have still to find a cane ristant to root discase. There is always the possibility of one being found as is shown by the raising of varieties of cotton resistant to wilt, which is another soil fungus. Planters themselves can and must assist in this, by observing whether any varieties, when planted on an estate scale, are more resistant to root disease than others, and publishing their results.

NEED FOR THOROUGHNESS.

In conclusion, I wish to point out that none of the methods I have recommended will kill out the root fungus, they will only keep it under. It follows then, that for them to be of any use they must be carried out throughly and systematically and continually, as part of the routine of estate work. The moment your efforts slacken, the fungus will again begin to take the upper hand and will soon be as bad as if nothing had been done.

SUMMARY.

A green plant obtains its food from two sources, the soil and the air. From the soil, the plant obtains its water and the mineral salts dissolved in it; these are passed up to the leaves. From the air, the plant obtains its carbon; this is taken in from the carbon dioxide of the air, and .is combined with water taken in by the roots to form sugar.

A fungus consists of a vegetative part, or "mycelium," and a reproductive part. The reproductive bodies are called "spores;" they are formed in various ways, generally in immense numbers. A fungus possesses no chlorophyll; it is, therefore, like an animal, dependent upon green plants for its organic food. Fungi that obtain this from living plants are parasites; those that obtain it from dead animal or plant remains are saprophytes; many fungi are capable of existing either as saprophytes or parasites according to conditions.

RIND DISEASE.

The spores of the rind fungus enter the cane at a wound. They germinate, putting out hyphae which enter first the thin-walled cells containing stored sugar. The hyphae afterwards enter the wood vessels and intercept the water current, so preventing the leaves from obtaining the water and mineral salts, which are necessary for the proper performance of leaf functions. The spores of the fungus are formed in immense numbers under the rind of the cane; that is finally broken through and a mass of spores emerge, all cemented together.

All rotten canes should be destroyed; boring insects, which produce wounds, should be got rid of; only perfectly healthy cuttings should be used for planting; the best cultural methods should be pursued. At present the rind disease is largely kept under by the use of resistant varieties of cane, which have, in Barbados, to a great extent replaced the Bourbon.

PINE-APPLE DISEASE.

The pine-apple disease attacks cuttings and prevents their proper development. It is more abundant in a dry than in a wet planting season. Experiments, on a small scale, seem to show that dipping the cuttings in Bordeaux mixture and then tarring the ends will prevent infection.

ROOT DISEASE.

The root disease is caused by a fungus, *Marasmius sacchari*, which enters into, and destroys, the growing point of the root tip. The fungus is capable of existing as a saprophyte, and the mycelium is found on dead and dying parts of the cane plant, as well as on decaying vegetable matter in the soil.

The leaves of attacked plants dry up, first at the tip and edges; the dry leaf-sheaths, at the base of the plant, do not fall off clean, but remain attached to the stem and matted together; the canes are dwarfed, and are easily uprooted. The fungus produces small, white toad-stools near the ground, in wet weather; on these are borne the spores of *Marasmius*. The fungus spreads by the spores, and to a greater extent by its mycelium which grows underground from one cane to another.

The root fungus is not able to do much damage to a cane plant which is growing vigorously, under favorable conditions; it waits for an opportunity when the conditions are unfavorable to root development; this usually occurs when the plant canes are cut back and allowed to ratoon.

Very careful attention should be paid to cultivation, so that the soil conditions may be as favorable as possible to root development; a small diseased area should be isolated by a trench 12 to 18 inches deep, which should include one or two rows of apparently healthy canes; the strictest attention should be given to the selection of "plants" and "tops," these should never be taken from an infected cane plant or even from an infected field; all infected cane stumps should be burnt or buried with lime; the greatest care should be taken that no infected trash is ever used on a cane field; canes infected with root disease should not be allowed to ratoon; badly infested land should be rested, for two or three years, from cane. There is a possibility of raising resistant varieties of cane, an special attention is being devoted by the Imperial Department of Agriculture towards this end.

(Concluded.)

SUGAR CANE IN CUBA.

BY H. A. HIMELEY, OF HAVANA.

Sugar cane is a plant which has been known since very early times. It is mentioned in the Old Testament as the "sweet cane of Egypt," in which country it is cultivated at the present time for the manufacture of sugar.

It is a curious fact that although the cane bears a flower in the shape of a beautiful silky, glossy tuft, two feet or more in height, which grows at the extremity of a reed several feet in length, which reed forms the upper extremity of the cane when mature, yet the seeds which are formed on this tuft rarely posses the powers of germinating. The reason for this is that the sugar cane has been planted since many centuries not from the seed, but from pieces of the cane itself, which are placed in furrows in the ground prepared for the purpose, and which are then covered with the soil. Consequently, by a just retribution of Nature the gift of germinating, so long left in disuse, has been lost to it—or very nearly lost.

Of late years agricultural and botanical institutions have taken great interest in experimenting with the seeds of the cane, and in some instances have met with some reward for their labors. Should it prove possible to raise sugar cane to any reasonable extent from the seeds, the discovery would be of great importance to the cane industry, as the percentage of sugar contained could be considerably increased by the selection of seeds, as it has been done with the sugar beet.

The cane grows in sections like a bamboo stick; these sections, or divisions, are generally from four to eight inches long; they extend the whole length of the cane from the root to the top, where there grows a mass of long, ribbonlike leaves. The last few sections of the top are not sweet, like the rest of the cane; they contain glucose, and are unfit for sugar making. When the cane is cut down for grinding purposes these tops are lopped off, and, together with the mass of leaves which is attached, form an excellent fodder for cattle; in fact, they are the principal article of food, during crop time, for the cattle on the plantation.

The division between the sections consists of a harder and more woody substance than the rest of the cane. A little ridge, forming a circle or ring around the outside of the cane, marks the dividing line between every two sections. At each of these divisions there grows a small eye; this eye is what gives birth to the new plant when the cane is placed underground.

The height attained by the cane varies very considerably.

It depends upon the richness of the soil, the degree of cultivation received, the rainfall during the growing season, and the number of crops already gathered from the same roots. A period of drouth will leave its imprint unmistakably upon those sections, or knots, which are being formed at that time; they will remain short and stunted. An average cane field in Cuba may stand from about eight to twelve feet high; canes do grow, however, twenty feet high and over.

A field of sugar cane, especially when the cane is still young, resembles a corn field, and a traveller in a railroad car who sees one for the first time sometimes takes it for corn. Later, when the cane has grown, and the leaves have attained their normal size, the resemblance is much less.

The leaves are three feet or more in length, and two or three inches wide at the widest part. They grow at each division or knot in the cane, but principally at the top of the cane, where there is a large mass or bunch of leaves.

As the cane develops the leaves which grew out at the joints or divisions of the cane dry up and fall, and the ground becomes completely covered with a thick mass of dried leaves.

There are many kinds of cane known in the world, but those most commonly seen in Cuba are what is called "Cristalina" cane, purple cane and the purple striped. The former is the best and by far the most generally planted. The two other kinds mentioned are of a harder and more woody nature. Cristalina cane is of a light yellow-green color.

In the favored climate of Cuba cane may be planted in almost all the months of the year, but the principal planting seasons are spring and fall. The first extends from March to June; the second from September to January. After January the plantings are termed "ventureas," which means that they are planted on a venture, their success or failure depending upon whether rain falls or not within a reasonable time after the planting.

Plowing is all done with oxen or bulls; usually two yoke of oxen are used, sometimes as many as three, to each plow. The plows are of the best American make. Occasionally, however, one sees the old-fashioned Cuban plow used by some of the small farmers. It consists of a sharp, pointed stick, which is drawn through the ground by oxen, making a shallow furrow, with a single upright piece, or handle, to guide it. The point of the stick is sometimes encased with iron.

Planting and cultivating is generally carried on in much the same way to-day as it was many generations ago, but the most enlightened planters, forming part of the Agrarian League of Cuba, with an eminent authority on cane planting and cultivating, Dr. Francisco Zayas, at its head, are conducting a campaign of enlightenment, and the Cuban Government is at this time establishing agricultural institutions in the island; and the results from these efforts cannot fail to bring more advanced methods into practice.

The ground is prepared by plowing in one direction and then across; sometimes it is given a third plowing. The field is then harrowed, and a light plow traces the furrows in which the cane is to be planted. These furrows are from three to six feet apart. The cane which is to be used as seed is cut into lengths of about twelve inches. These are laid in the bed of the furrow, lengthwise with it, sometimes end to end, sometimes leaving a space of about twelve inches between each two sticks of cane. Sometimes two sticks of cane are laid in the furrow, parallel to each other and a few inches apart. A light plow is run alongside the furrow and the earth turned over so as to cover the cane. If the ground is damp and in good condition the cane may be expected to show itself above ground in about three weeks' time. Weeds also soon make their appearance, and the work of destroying them should not be delayed. This is done by hoes and by running a cultivator or a light plow between the lines of cane.

Both oxen and mules are used in the cultivation. The operation of weeding must be repeated as often as necessary, never less than three times, until the cane leaves have grown so that they completely overspread the ground and prevent the sun from penetrating to the soil. When this degree of development has been obtained the weeds no longer make their appearance. The cane takes from twelve to fifteen months to mature. After it has been cut down new canes come up from the same roots and the field has to be weeded and cultivated as it was for the first crop. This new crop can be cut after twelve months' time and the operation repeated. The number of crops which can be cut from one planting varies according to the quality of the soil, from three crops on medium lands to six and eight, or even more, on the best lands.

Where forests are cut down in order to plant cane the system of planting and cultivating is necessarily different, because the stumps which remain in the ground, even after burning, make the use of the plow impossible. Planting has to be done with hoes, or else by means of a sharp pointed stick, in the hand of a man who walks in a straight line across the field, and who thrusts the stick in a slanting direction into the ground, making a hole into which a piece of cane is inserted, and the earth is pressed tight around it. Weeding must, of course, also be done with hoes. These lands from which the virgin forests have been cut are the ones which produce the heaviest crops, although the cane is not usually as rich in saccharine as in the older lands. A yield of from 33 to 45 tons (2,240 pounds each) of cane per acre may be had from such lands, sometimes even more, whereas the average yield in the island probably does not exceed sixteen or eighteen tons per acre. In the earlier days of cane planting in Cuba, when transportation facilities were lacking, the finest mahogany and cedar trees were burned where they fell, in order to prepare the land for planting cane.

Cane is the favorite crop in most parts of Cuba, and almost every one living in the cane districts knows how to raise it, or thinks he does. From the owners of immense landed estates and central factories down to the humblest farmer who cannot write his own name, all plant cane and talk cane. In the country districts the doctor and the blacksmith, the lawyer, the mason and the shopkeeper, each one has an interest in some piece of land planted with cane to be sold to the neighboring central factory. The owner of the "central" has immense fields of cane of his own, and generally aims to plant in time all the cane required for his mills. But his plant, which represents an investment in machinery, lands, buildings, railroad lines and equipment of anywhere from $300,000 to $1,000,000, and which turns out, according to its size, from 50 to 250 tons of sugar per day, requires a daily supply of from 500 to 2,000 tons of cane during the crop season, which lasts about five months, and the planting and cultivation of this amount of cane is no small matter. Consequently he allots portions of his land, small or large, to tenants, according to their ability to cultivate it. These tenants, or "colonos," as they are termed, usually put up a small cottage on the land, live there and plant the cane, which they deliver to the mill during the grinding season. The price paid them for the cane is usually based upon the value of sugar at the time the cane is delivered. The "colono" usually gets the market value of from 4 1-2 to 6 1-2 pounds of sugar for every 100 pounds of cane delivered, the amount depending upon the competition for cane which exists in the district between the different centrals, upon the nature of the soil, and upon the amount of financial assistance he requires from the central. For the owner of the central is a banker as well as an agriculturist and a manufacturer. Besides the "colonos" who have settled on his own lands, he makes contracts with a large number of outside "colonos" who possess lands of their own, or who lease lands from third parties, which they plant in cane. A central factory may very likely have contracts with one or two or three hundred different "colonos." Some of these cultivate only small patches of cane, while others have farms consisting of thousands of acres. As a rule all require financial assistance. This they get from the owner of the central factory, and the latter must see to it that his advances are paid back by the cane during the crop season. That season lasts in most parts of the island from December to May.

The cane has been growing during the hot rainy season, and the cool drying winds of winter have come and brought about the changes needed in the sap to produce the sugar. At break of day the cane cutters—negro men and women, white men, mulattoes and Chinamen, each one carrying a sharp "machete" with which to cut down the cane—start out for the fields. Having arrived at the field which is to be cut, they take up their positions along the outside edge of the standing cane, leaving sufficient space between them and their next neighbor to allow of the free wielding of the machete, a broad, sharp blade about eighteen inches long, and quite different from the machete which played a prominent part in the late revolutionary war. The cane extends far above their heads. They seize a cane with the left hand, one blow of the machete severs it, as close to the earth as possible; the cane is given a turn which brings the upper extremity near the cutter, a second blow lops off the head of the cane with its heavy top of leaves. The back of the machete is then run rapidly along the length of the cane, in order to free it from the dried leaves remaining at the joints or knots; one, two, or more quick blows, according to the length of the cane, divide it up into lengths of about three or four feet, and these pieces are slung into a pile, the last cut being given while the cane is in the air on its way to the pile. The whole operation takes infinitely less time to carry out than it does to describe. The heavy two-wheeled carts drawn by oxen drive into the cane fields, and the cane is handed in armfuls to the driver, who stands at the rear end of the cart and stows it away evenly. The carts generally carry a load of from one to one and a half tons.

Fires are of frequent occurrence in the cane fields during the crop season, and the reason of this is easily understood. The ground, as we have seen just now is covered with a mat several inches thick of dried cane leaves fallen from the cane and resembling a bed of straw. During the daytime, when the tropical sun is pouring its rays down on these fields, it suffices that a cigarette stump or a match be carelessly thrown away to start a blaze, and many of the cane cutters are smoking while standing ankle deep in this straw, or a passerby on an adjoining road may start the fire by similar carelessness. Many fires are purposely set; it is much less labor to cut the cane when a fire has swept over the field, burning up all the leaves, and leaving only the cane standing like so many sticks. The fire also destroys the nettles which in some cane fields make it very painful to cut the cane. Consequently the man who has the contract for cutting the cane, or one of his men, will sometimes set fire to the field on the sly, in order to facilitate the work. When once a fire is started there is no knowing where it will stop—perhaps half a mile away. The burnt cane is cut at once and ground; if ground within a few days after burning, and no rain has fallen meantime, it serves for making sugar, though never as good as that from fresh cane. Rain falling on burnt cane turns it sour and renders it worthless. Setting fire to a man's cane field is also a favorite way of avenging an injury in Cuba, and central factories who have had differences with their colonos have sometimes had nothing but burnt cane to grind for weeks at a time. A lighted candle is sometimes placed in the interior of a cane field, and before the candle burns down to the straw and starts the fire, the rascal who placed it there has ridden far away from the scene. When a fire starts in the cane all hands turn out to fight it, and sometimes several hundred people gather for the purpose, the most successful way of stopping it being to set a counter fire.

The carts used in Cuba are heavy and cumbersome; the body is rudely constructed of heavy timber, fastened to the axle without any springs. There are two wheels about six feet in diameter, with heavy iron tires about five inches wide. The cart has upright stakes, so as to hold the load of cane. Two oxen or bulls are yoked by the horns to the pole, which is made of heavy timber. Usually one or two more yoke of oxen are attached to each cart, ahead of the wheelers. The front yoke pulls by means of a rope, twenty-five or fifty feet ahead of the next yoke, so that when a bad spot is met in the road the first yoke is far head of it before the others reach it. The oxen are all yoked by the horns, the Cubans contending that therein lies the animal's strength. The driver carries a long goad with a sharp iron point, which he uses mercilessly. When an ox dies which has seen service and his hide is removed and dried, the part over the hindquarters is seen to be perforated by countless holes made by the goad. In some cases when the gentle remonstrance of the goad passes unheeded the driver will take the lower part of the animal's tail between his teeth and give it a hearty bite. This argument generally proves infallible.

Those farmers or "colonos" who are near enough to the central to do so cart their cane to the mill. On arriving at the factory the cart loaded with cane is weighed, together with the first pair of oxen, on a Fairbanks platform scale, the tare of the cart and oven being taken afterward. The cart then backs up to the cane carrier, which is an endless platform, or conveyor, probably two hundred feet long, passing over drums and moving constantly toward the mill. The driver discharges his load on to the conveyor, which carries it along and drops it, by means of a chute, into the mill.

Many of the "colonos," however, are situated much beyond carting distance from the central; some of them are fifty miles or more away. In fact, as a rule the greater part of the cane is too far away to be carted to the mill, and has to come by railroad, either by private lines built by the central, which has sometimes standard gauge and sometimes narrow gauge, or else over the lines of the public railroad near which the central is situated.

The central has therefore a regular railroad organization of its own to look after, comprising many miles of track and possibly from three to six or more locomotives and fifty or a hundred cars for hauling cane. A cane train consists generally of a locomotive and twenty to thirty cars, each car carrying about 25,000 pounds of cane. These trains usually leave the factory at daybreak with empty cars, which are distributed to the different "colonos" along the line, and are brought back loaded in the afternoon or evening. The "colono," of course, brings his cane in the carts already described from his fields to the place where the empty car stands. There are appliances by which the entire load of cane is lifted from the cart by means of ropes previously placed in the bottom of the cart, and is transferred to the railroad car, the lifting being done sometimes by a small engine, sometimes by oxen. Where these appliances do not exist, the transferring of the cane is done by hand.

Let us now take a hasty glance at the factory, or sugar house, and see what becomes of the cane.

We have seen the "colono" who brings his cane in carts discharging it in the cane carrier or conveyor; the railroad cars loaded with cane are also brought up alongside of this cane conveyor and their contents are transferred to it. In many places this work is done by hand, and one often sees two cars being unloaded at the same time, six or seven men being actively engaged in each car throwing armfuls of cane on to the conveyor in order to give the mill the required feed. Mechanical means of unloading the cane cars are, however, gradually taking the place of hand labor. There are different ways of doing this; sometimes by means of a crane and chains, which lift the cane out of the cars; sometimes by tilting the car and empting its contents on to a platform, from which it is mechanically transferred to the conveyor.

The mills are very powerful and are composed of three iron rolls from five to seven feet long and from twenty-four to thirty-six inches in diameter. The cane receives two pressures while passing between these three rolls. There are never less than two, and sometimes three, of these mills in a factory, and the cane passes through them all so as to extract as much of the juice as possible. There is frequently a cane crusher through which the cane passes before entering the mills. The crusher resembles a mill, but the surface of the rolls is corrugated, so as to cut and partly crush the cane.

This operation facilitates the work of the mills and the extraction of the juice.

The juice coming from the mills is run into circular vessels or tanks, called defecators, usually having a double bottom into which steam is admitted. Lime is added in order to neutralize the acidity of the juice and to cause the impurities contained to rise, as they do, in thick scum to the top. The clear juice which is underneath is then run off. The scums are pumped through filter presses, and yield a considerable amount of good juice.

The cane juice after leaving the defecators is evaporated in a triple effect apparatus in which a partial vacuum exists. It there becomes a syrup. The triple effect apparatus is composed of three separate bodies so constructed that the vapors rising from the boiling juice in one of the bodies causes the next one to boil, and this one in turn performs the same service for the third body of the triple effect, thereby effecting a great saving in fuel. The syrup which comes from the triple effect is then cooked in a vacuum pan—or strike pan, as it is called—until the crystals of sugar have been formed. The contents of the pan, or masse-cuite, then go to the centrifugals, which revolve at the rate of 1,200 or 1,400 times a minute, and which separate the molasses from the sugar. In many places the masse-cuite coming from the strike pan, instead of going at once to the centrifugals, is run into small iron sugar wagons and is left there two or three days before being put through the centrifugals. A slow crystallization goes on until the masse-cuite is entirely cold, and an increased yield of sugar is thus obtained.

The latest manner of treating the masse-cuite, however, is to empty the contents of the strike pan into large iron receptacles, in which a revolving shaft, with blades attached, keeps the mass in motion for a certain number of hours before it goes to the centrifugals. This process is based upon the fact that while sugar crystals are in motion their volume increases to a greater extent and more rapidly than when at rest.

The sugar which on entering the centrifugals was black has in five or six minutes become of a light yellow color and is ready for the market. It is put up in jute bags containing usually about 320 to 325 pounds.

The molasses which has been separated from the sugar by the centrifugals is cooked over and an inferior grade of sugar made from it. In some factories, however, only one grade of sugar is made, and as much of the molasses as possible is introduced into the manufacture of that grade.

Meantime the woody part of the cane which has gone through the mills, and which is called "bagasse," drops on a conveyor, or "bagasse carrier," and is conveyed and dropped automatically into specially constructed furnaces, where it burns and supplies all the fuel needed for the factory, with the exception, possibly, of a small quantity of wood which may be required to light the fires. This holds good only as long as the mills are kept going, for the moment they stop, the supply of fuel going into the furnaces naturally stops also. Consequently the manager of a sugar house sees to it that he always has a sufficient supply of cane on hand to keep his mills going without any stoppage.

Work in the sugar house goes on day and night during the crop season with two gangs of men, who usually work six hours on and six hours off.

The central factories are connected by a line of their own with the railroad which is situated near them, and the railroad cars come to the doors of the factory and are there loaded with bags of sugar, usually one hundred bags of 320 or 325 pounds, each going in a car. Freights are very high, and it generally costs a good deal more to send a bag of sugar thirty or forty miles by railroad to a seaport than it does to take the same bag from that seaport to New York, which is 1,450 miles away.

Some plantations are situated so near the coast that they do not require to pay tribute to the railroads, which is, of course, a great advantage.

The sugar made in Cuba is all raw sugar, and is sold to refiners in the United States, with the exception of a small amount consumed in the island.

The principal shipping ports are Cienfuegos, Cardenas, Matanzas, Havana, Sagua, Caibarien, Gibara and Puerto Padre, Manzanillo and Guantanamo. The exports to the United States will probably amount to 1,000,000 tons this year.—[The Federal Reporter.]

INSECTS BENEFICIAL TO MAN.

BY JOHN ISAAC.

[Continued from July Number, Page 306.]

Another family belonging to the same order as the ladybirds is the ground beetles. There are some 1200 species of these in the United States, and all are beneficial. They are not so conspicuous as are the ladybirds, as they have the habit of hiding under clods and stones and very many of them are nocturnal in their habits, while the greater part of them are either black or brown in color and resemble at a general glance other members of the coleopterous order. They live largely upon other insects and very largely upon caterpillars and the larva of insects which attack our plants. Besides these there are the tiger beetles, and the carrion beetles, and very many others which are beneficial to us directly and indirectly.

Probably the next order to which we are most deeply indebted is the Hymenoptera. It is this order which gives us the bees and the wasps. The Ichneumons belong here and in this very numerous family we find the most diligent workers in our interest. Very many of these lay their eggs upon or in the caterpillar tribes, and out of the many of these crawling pests of our gardens, few ever attain perfect growth owing to the work of their Ichneumon enemies. It is in this group, too, that we find the most effective enemies of the scale bugs, and in fact it is largely due to the work of the hymenopterous parasites that we are enabled to produce fruit at all. Most of you remember the prevalance of the San Jose scale in our State a couple of decades ago. This pest had, unobserved, got a foothold in our State, and had spread all over it before we discovered the danger of it. Our deciduous trees were dying under its malign influence and peaches and apples and other trees subject to its attacks were being dug up and destroyed by thousands, very much as they now are in the Eastern States where it has appeared. We were put to our wits' end to check it, and in this effort very many of the remedies which we use today originated, but all our efforts were in vain, for while we found the salt, sulphur and lime wash was an excellent check, we were not able to prevent its destructive spread. At this juncture a minute internal hymenopterous parasite was found to have adapted itself to it, and gradually the San Jose scale disappeared until today we do not regard this scale as a serious pest, although it is still reported in isolated sections at intervals. This parasite, the Aphelinus fuscipennis, is one of our native varieties and is generally distributed all over the country. It is claimed that it is not so effective in the east as in California, as the seasons there are shorter and it is not as many-brooded there as here. Professor Johnson, of Maryland, who spent some time in California and is acquainted with the work of parasites here, made the following statement before an annual meeting of economic entomologists in regard to its work in his State:

"Last fall I discovered a new locality for Aphelinus fuscipennis near Easton, Talbot county, in an infested orchard along the Miles river, the orchard containing a miscellaneous variety of fruit and all the trees quite seriously infested with San Jose scale. Instructions had been given to the owner to cut them down and burn them. A quantity of small branches incrusted with scale were brought to the laboratory and inclosed in breeding tubes. Much to my surprise these tubes were swarming with parasites a few days later; from one tube 1114 specimens of Aphelinus fuscipennis were taken, while the second tube gave 432, a third 1478 and a fourth more than 1000, but owing to an accident the count in the case last mentioned was not exact. The writer was greatly elated over this discovery."

The Scutellista cyanea, which has done such remarkable work on the black scale in the short time it has been with us, and from which we hope so much in the future, is a member of this order. This parasite, in the sections where it has become established, has practically annihilated the black scale and from centers where first established it has radiated until it already covers large areas, and gives us grounds for hope that the black scale, as a pest, is practically a thing of the past. We have secured this insect without its secondary parasite, so there is nothing at present to check its unlimited spread; but, of course, there is danger that some of our native varieties may adapt its taste to the Scutellista, and it may not spread so rapidly in the future as it is now doing. These, however, are mere surmises, and, from present appearances, the Scutellista will make for itself a record on the black scale equal to that of the Vedalia on the cottony cushion scale.

This order gives us parasites of the soft brown scale of the orange, which at one time was as great a pest as the black scale lately was. It has given us an effective parasite of the yellow scale, and very many others, until today in conjunction with other beneficial insects the damage from the scale family has been reduced to a minimum. The most serious of our scale pests today are the red scale and the purple scale, for neither of which we have yet secured a satisfactory parasite.

The larger numbers of this order prey upon other insects, and most of you have seen a yellow jacket capture a horse fly very much exceeding it in size, quickly cut off its head, remove its wings and fly away with the dismembered body. If you will open the nest of one of our common mud daubers you will find it packed solid with either small grubs and caterpillars or spiders, which have been carefully stored to supply the young larva when it shall be hatched out. I have opened a number of such and found them to contain twenty or more of the caterpillars of our destructive oak moth, and I believe they do much in keeping down this pest. Altogether there are more beneficial insects in this order than in any of the others, in fact, nearly all are of benefit to us in some way or other, and while some of its members may injure our grapes and ripe fruit by puncturing the skin and carrying off the juices, still, in view of the immense benefits which we receive from the order at large, we might put up with the inconvenience this causes us.

Even the order of true bugs, the hemiptera, in which we find the greater part of our worst pests, including phylloxera, aphids, scale bugs, and the various plant bugs, is not without its redeeming members, and here we have very many predaceous insects, which devote their lives to sucking the juices from the bodies of other insects which do us damage. One whole family, the Reduviidae, or as it is commonly known, the assassin bug, is engaged in this work. They have been called by the latter uncomplimentary title from the fact that they prey upon other members of their kind. This is a very large family, comprising nine sub-families and at least fifty genera. They are large insects, usually prettily marked and may all be classed as beneficial, as they live as a rule upon the blood of other insects. Some of them, however, attack the higher animals, and even man himself is sometimes made their victim. The kissing bug, which attained a great deal of newspaper notoriety a few years ago, belonged to this family.

In the Diptera we find very many beneficial species, although it also gives us the mosquito and the house fly. And I have seen it stated that where they were not too numerous to be annoying, the house flies are beneficial, in that they clear the air of germs which might otherwise breed disease, that they are general scavengers and do more good than harm. After a flight through the air, you will often see a fly settle down and go over his legs and wings with his antennae, carefully removing the particles which have adhered to them. It is claimed that in his flight he has gathered up quantities of disease germs, and in this act of cleaning himself he is devouring them. I cannot vouch for this, but I have been in some situations where I should have preferred all risk from germs to the plague of flies. Were it not for the work of flies and other insects as scavengers, however, there is no doubt that we should suffer very much from infectious diseases, for they are the greatest natural force in the removal of dead and decaying substances, and it is astonishing how rapidly the carcass of a large animal will be removed by these insignificant members of the animal world. This order gives us the big family of syrphus flies, the members of which resemble various kinds of bees and wasps, and most, if not all of which are beneficial. They are all predaceous and devour aphids in enormous quantities. You have doubtless often noticed one of these flies hovering almost motionless over a flower bed, its body banded with black and yellow rings, resembling very much our common yellow jacket. It will remain thus poised in the air for moments together, when, with an almost lightning-like motion it will dart upon its prey, and then again take up its motionless position in the air. The larva of these flies is a small maggot which is generally domiciled in a colony of aphids. Its head is a sharp pointed beak, which more resembles a tail, but in this sharp point are the sucking parts, and with it the grub picks up aphis after aphis, sucks their juices, and drops the empty skins. One of these syrphus larvae will very speedily clean out a large colony of aphids.

The Tachina flies are another very large and beneficial family belonging to this order. The adults of these lay their eggs on other insects, very largely upon grasshoppers, and play an important part in keeping down that pest. During the visitation of grasshoppers at Livermore last year these tachina flies were very numerous and whenever a grasshopper was seen in the air, there, too, would be seen one of its enemies darting at it and almost instantly leaving the fatal egg which was to hatch out the grug destined to eat its victim alive. Other families in this order furnish us with friends.

The Neuroptera is crowded with our friends. Here we have the dragon fly, who devotes his life to eating up the pestiferous mosquito, and without whose aid, there is no doubt, that pest would be much more numerous than it now is. The lace-winged fly, one of the prettiest and most delicate of the insects, and one of our best friends, is a member of this order. This is another of the many predaceous insects which feed upon aphids. Another member of this family is the Raphidan, a rather strange looking insect, somewhat resembling a small mantis in general appearance. The members of this family are all carnivorous and are found in orchards, where they live, among other things, upon the larvae and pupae of the codling moth. Unfortunately, they are not sufficiently numerous to keep the pest in check.

Now, I think if you will consider this matter, you will see from what little I have said that we owe much to our insect friends, and in spite of all the ills we suffer from them, they are as a whole really more beneficial than injurious to us. And, now, another word in regard to parasites. I believe where these are established that they are infinitely better, more effective and cheaper than any artificial remdies that we can apply.

Cromwell's advice to his soldiers was to put their trust in God, and to keep their powder dry. So I would say, put your trust in parasites, and you will not be deceived, but be sure you have got them and that they are effective before you stop fighting your insect enemies.

BEET VS. CANE SUGAR.

(From United States Consul Hossfeld, Trieste, Austria.)

Those who hoped that among the beneficial effects of the Brussels convention would be a large decrease in the production and a corresponding advance in the price of sugar have been disappointed.

While the production of beet sugar has decreased about 13 per cent. during the last two years, or from 6,760,000 metric tons to 5,900,000 metric tons, that of cane sugar has increased during the same period from 4,063,000 metric tons to 4,437,800 metric tons, or about 9½ per cent.

On the other hand, the average price of sugar f. o. b. Hamburg was, for the quinquennium 1898-1902, $2.21 per 50 kilograms (110.2 pounds); for the year 1903, $2.01; and for the last month of 1903, $2.05.

It is thus seen that there has been no material decrease in the total production of sugar since the Brussels convention, and that prices at the end of 1903 were only 2 per cent. above the average for the year and more than 7 per cent. below the average for the last five years.

At present the tendency of prices is again decidedly downward and a change for the better need not be looked for as long as the world's surplus of 2,000,000 tons remains unabsorbed.

The following table gives the estimated production and consumption of sugar in the various countries of Europe for the current campaign (1903-4):

Country.	Production. Tons.	Consumption. Tons.	Available for export. Tons.	Required import. Tons.
Germany	1,940,000	850,000	1,090,000	....
Russia	1,200,000	850,000	320,000	....
Austria	1,230,000	400,000	830,000	....
France	770,000	580,000	190,000	....
Belgium	225,000	85,000	140,000	....
Holland	125,000	90,000	35,000	....
Sweden	100,000	100,000	....	....
Spain	90,000	90,000	....	....
Italy	125,000	125,000	....	....
England	....	1,600,000	....	1,600,000
Other countries	72,800	258,800	....	186,000
Total	5,877,800	5,058,800	2,605,000	1,786,000

These figures show that a foreign market must be found for a surplus of more than 800,000 tons of Europe's production. But it becomes more difficult from year to year for Europe to dispose of its surplus. Within two years the world's production of cane sugar has increased from 4,063,000 tons to about 4,438,000 tons. There is every indication that the beet and the cane will enter upon a long and destructive war for final supremacy. Germany, Austria, Italy, Belgium, and Holland are increasing their production of beet sugar during the present year, Austria's increase alone amounting to 175,000 tons. Russia's production remains stationary and France is the only country where a reduction may be looked for.

The beet-sugar interests are determined not to give up their foreign markets without a desperate struggle. Nor is it difficult to account for their attitude. An immense capital has been invested in the beet-sugar industry, which has thereby been brought to a high degree of development. Hundreds of thousands of laboring people, furthermore, rely upon this industry, directly or indirectly, for their support. Both capital and labor, therefore, oppose surrender, and the only question which at present concerns European sugar interests is how best to fortify themselves against the enemy's attacks. A retrospective view within their own field of activity suggests the policy to be pursued. All small and inefficient sugar factories have in the course of time been starved out and only the largest and at the same time best equipped and best conducted plants have survived. The latter survived because they were able to manufacture on a large scale and therefore at a comparatively low cost. That the increasing production of cane sugar will bring prices to a still lower level than the present admits of no doubt, and the manufacturers of beet sugar realize that they must be prepared to meet the new and increasingly critical condition of the market or withdraw from the contest. As experience and observation have made it clear to them that the cost of production can be lowered only with an increased output they are determined to work their respective plants to their utmost capacities and thus continue to swell Europe's already formidable surplus of sugar rather than permit the producers of cane sugar to derive from the Brussels convention any advantage likely to increase their power of resistance.

In other words, overproduction has been chosen by the European beet-sugar interests as the most effective weapon of defense in their fight against the rising power of cane sugar in the markets of the world. Whether this will really avert or only postpone the threatened crisis at home remains to be seen.

FREDK. W. HOSSFELD, *Consul.*

Trieste, Austria, April 6, 1904.

SUGAR IN TRINIDAD.

The principal exports of Trinidad are sugar (and its by-products), cocoa, asphalt, cocoanuts, and cocoanut oil.

Exports of cane-sugar products—

Description.	1901-2.	1902-3.
Sugar, tons	45,000	47,000
Molasses, gallons	482,000	301,000
Rum, gallons	178,000	213,000
Bitters, gallons	32,000	39,000

Sugar is prepared exclusively from the sugar cane in the large "Central" factories in the colony. In these factories cane sugar is produced, polarizing 98 to 99 per cent. of pure sugar. During the last eight years there has been a most striking change in the relative position of sugar and cocoa. In 1895 the market price of sugar had fallen to $40.80 and the sugar industry was in danger of extinction. Prices were then believed to have reached the lowest mark, but in 1902 they fell below $28. Since then many of the factories have closed down. However, the larger plants are still operating, one producing 15,000 tons per year, but the present prices of sugar are so much below the cost of production that this industry is in a very precarious condition.

Large quantities of molasses are produced in connection with the manufacture of sugar. Some is used as cattle food and some converted into rum; but there is usually a surplus, which is sometimes unsalable at a profit. A suitable outlet for this surplus stock is very much required.

Rum is made locally from molasses, and 300,000 gallons are consumed annually in the island. Of the total exported last year England received 146,000 gallons, Venezuela 57,000 gallons, and the United States 8,000 gallons. The well-known Angostura bitters is made in Trinidad from rum of the finest quality produced in the island. The other ingredients are a trade secret. During the year ended March 31, 1903, Angostura bitters was exported as follows: To Germany, 13,000 gallons; to England, 11,000 gallons; and to the United States, 10,000 gallons.

BEET-SUGAR STATISTICS.

(From United States Consul Diedrich, Bremen, Germany.)

As the beet-slicing campaign for 1903-4 is about over, all interested in the making and selling of sugar are desirous of getting the latest information as to the results of this season. To such the following tables, which are largely based upon the reports of Mr. Otto Licht, the well-known sugar statistician, of Magdeburg, may prove of some value.

PRODUCTION OF BEET SUGAR.

The following is a comparative statement showing production of beet sugar in European countries during the last four years:

Country.	Met. tons. 1903-4.	Met. tons. 1902-3.	Met. tons. 1901-2.	Met. tons. 1900-1901.
Germany	1.960.000	1.762.461	2.304.923	1.984.187
Austria	1.175.000	1.057.692	1.301.549	1.094.043
France	810.000	833.210	1.123.533	1.113.893
Russia	1.200.000	1.261.311	1.098.983	918.838
Belgium	220.000	225.696	334.960	333.119
Holland	125.000	102.411	203.172	178.071
Sweden	106.500	72.444	125.948	114.734
Denmark	49.000	37.067	55.132	50.760
Italy	120.000	95.191	74.299	60.125
Roumania	18.000	16.381	20.844	18.714
Spain	116.000	96.160	73.576	87.479
Other countries	10.500	13.919	15.329	16.107
Total	5.910.000	5.573 943	6.732.248	5.970.070

AVERAGE CONSUMPTION.

The following is a comparative statement showing how much sugar was consumed by each inhabitant of Europe and the United States during the last three years:

Country.	Number of inhabitants. in 1903.	1902-3	1901-2.	1900-1901.
		Pounds.	Pounds.	Pounds.
Germany	58,512,000	28.31	30.07	29.81
Austria	47,600,000	17.86	18.34	17.95
France	39,000,000	23.56	25.43	28.16
Russia	109,000,000	17.88	17.44	14.36
Belgium	6,800,000	22.37	24.88	23.6
Holland	5,270,000	30.55	46.66	44.26

Sweden and Norway	7,450,000	39.57	45.51	39.38
Denmark	2,500,000	51.97	53.94	51.45
Italy	33,000,000	7.37	7.19	6.27
Spain	18,650,000	10.91	9.32	9.85
Roumania	6,100,000	6.73	6.27	7.32
Bulgaria	3,780,000	6.11	6.16	5.87
Greece	2,500,000	8.53	8.07	5.5
Servia	2,550,000	7.83	6.88	6.86
Turkey, including Asia	24,600,000	7.96	8.05	8.05
Portugal and Madeira	5,600,000	14.41	14.1	14.12
Switzerland	3,450,000	62.83	61.05	53.43
England	41,900,000	89.8	97.83	97.94
United States.....	78,700,000	66.39	70.44	66.63

ACREAGE AND CROP YIELD.

The following is a comparative statement showing the acreage sown to beets, the total beet crop, the crop yield per acre, and the amount of sugar per acre, during the past two years, and also percentage of sugar in the beets:

Country.	Area sown to beets. 1902-3.	1903-4.	Total beet crop. 1902-3.	1903-4.	Yield per acre. 1902-3.	1903-4.
	Acres.	Acres.	Met. tons.	Met. tons.	Met. tons.	Met. tons.
Germany	1,056,708	1,027,580	11,270,978	12,700,000	10.66	12.36
Austria	751,011	757,633	7,130,600	7,775,000	9.49	10.26
France	551,774	553,998	6,266,946	6,441,500	11.30	11.63
Russia	1,482,116	1,395,801	9,161,000	7,712,000	6.18	5.52
Belgium	129,480	142,083	1,441,000	1,546,000	11.13	10.88
Holland	78,084	99,688	771,900	935,800	9.12	9.39
Sweden	59,798	70,997	505,018	746,800	8.45	10.51
Denmark	38,795	38,795	303,800	386,000	7.89	9.95
Italy	111,195	123,550	1,000,000	1,050,000	8.99	8.5
Spain	83,485	85,250	670,479	975,000	8.03	8.71
Roumania	15,355	16,062	130,000	180,000	8.54	11.21
United States....	259,448	292,277	1,686,308	1,850,000	6.5	6.33
Other countries...	7,413	7,413	140,000	100,400	12.58	10.15

Country.	Amount of sugar per acre. 1902-3.	1903-4.	Percentage of sugar in beets. 1902-3	1903-4.
	Met. tons.	Met. tons.	Per Cent.	Per Cent.
Germany	1.668	1.9	15.64	15.43
Austria	1.408	1.597	14.83	15.56
France	1.51	1.444	13.29	12.49
Russia	.851	.859	13.77	15.56
Belgium	1.743	1.583	15.66	14.56

Holland	1.312	1.254	14.38	13.25
Sweden	1.211	1.5	14.34	14.26
Denmark	.955	1.263	12.19	12.68
Italy	.856	1.012	9.52	11.9
Spain	.83	1.15	10.35	9.9
Roumania	1.069	1.121	12.52	10
United States	.753	.718	9.9	10.5
Other countries	.252	1.062	9.91	10.46

PRODUCTION AND CONSUMPTION.

The following table for the year 1903-4 shows that most beet-growing countries have sugar to sell, after supplying their own wants:

Country.	Stock on hand Sept. 1, 1893.	Production.	Consumption.
	Metric tons.	Metric tons.	Metric tons.
Germany	320,880	1,960,000	970,000
Austria	63,959	1,175,000	450,000
France	635,322	810,000	600,000
Russia	239,881	1,200,000	925,000
Belgium	104,370	220,000	90,000
Holland	23,175	125,000	100,000
Sweden and Norway.	5,000	106,500	150,000
Denmark	2,250	49,000	60,000
Italy	19,200	120,000	115,000
Spain	18,552	116,000	95,000
Roumania	......	18,000	19,000
Switzerland	6,000	10,500	256,000
England	138,724	....	1,870,000
United States (beet and cane)	260,411	500,000	2,570,000
Total	1,837,724	6,410,000	8,270,000
Last year	1,573,637	5,995,217	7,339,122

PRODUCTION OF SUGAR CANE.

The following is a comparative statement showing production in cane-sugar countries during the past five years. Of course, the figures for 1903-4 can only be approximate estimates, as the harvesting in some of the cane-producing countries, according to the latest advices, has just begun and the results had to be anticipated.

	1903-4. Met. tons.	1902-3. Met. tons.	1901-2. Met. tons.	1900-1901. Met. tons.	1899-1900. Met. tons.
Cuba	1,150,000	943,500	683,312	512,061	281,420
Porto Rico	125,000	77,737	82,179	55,089	32,751
Trinidad	40,000	38,804	44,913	47,942	38,003
Barbados	35,000	29,786	46,314	61,074	47,019
Martinique	35,000	33,107	31,733	39,550	30,175
Guadeloupe	35,000	38,828	40,576	38,529	28,091
Demerara	110,000	122,357	118,193	95,188	78,751
Brazil	150,000	139,000	268,000	228,000	165,000
Java	850,000	784,169	719,814	704,456	697,341
Philippines	110,000	114,343	67,331	54,943	66,116
Mauritius	180,000	147,630	145,268	174,938	159,102
Reunion	35,000	40,962	30,120	42,631	29.377
Jamaica	20,000	14,916	16,243	16,712	19,240
Lesser Antilles	80,000	80,000	95,000	85,000	80,000
Peru	100,000	110,000	100,000	105,000	100,381
Egypt	85,000	90,000	96,000	94,880	87,822
Hawaiian Islands	395,000	397,319	322,590	325,798	262,669
Total	3,535,000	3,202,458	2,907,586	2,681,791	2,203,258

STATUS AND OUTLOOK.

Such is the present statistical status, and such is the outlook. Both are not very promising, yet they are not so desperate as some would have them appear. In fact, there is hope for better things the coming season. In consequence of the Brussels convention the bounties were abolished, and naturally the sugar prices and more particularly the sugar production could not yet well adjust themselves to this change in so short a time. Nor will this process of readjustment be completed in the near future. Of course, nothing certain is known about the probable area to be cultivated next season, but this question is now being discussed by the sugar men generally. The German manufacturers of sugar are satisfied that nothing short of a positive reduction in acreage all over Europe will bring the beet-sugar business back to a paying basis; hence they will bend all their energies to bring about this result. However, this has been the usual cry about this time of year, and yet the statistics at the end of the year have always shown a steady increase of acreage. Yet there never was such an urgent reason for a reduction as at this time. Besides, there will be a greater scarcity of field labor in Germany than ever before. In consequence of the Russo-Japanese war the police regulations will be more strictly enforced along the border of Russia and Prussia, and it is reported that no passes will be issued to the 300,000 Russian Poles that usually come into Germany early in the spring, cultivate the sugar-beet fields all season, and then return to their Russian homes late in the fall. The authorities of the Province of Saxony have taken steps to get substitutes for them from Galicia, but with what result is not yet known. Russia herself will probably have to reduce her production, but this will hardly have any effect upon the world's sugar markets one way or the other, as it is generally supposed that she has quite a supply of old stocks on hand. A substantial reduction is looked for in France, where the yield has been poor during the last two seasons, with poorer beets from poorer soil, grown in a less scientific manner.

WORLD'S PRODUCTION AND CONSUMPTION OF SUGAR.

Altogether, it is expected that the decrease in sowings in Europe will be moderate, and that the acreage will be about 308,000 acres less. On the other hand, there is no doubt that the production of cane sugar will be increased by at least 150,000 tons. If nothing unusual happens, the world's consumption will increase about 500,000 tons.

HENRY W. DIEDRICH, *Consul.*

Bremen, Germany, February 29, 1904.